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DIABETES.

Thesis for the M.D. Examination, 1907.

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BY

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INTRODUCTION.

The following few pages were written as a Thesis for the Doctor of Medicine Examination of the year 1907. It deals with *Diabetes*—a disease most widely prevalent in Lower Bengal. During ten years of practice in the very heart of the town, numerous cases were recorded, as set forth in the Appendix under different headings. It is on the basis of these observations that the body of the Thesis was written.

Although 1,200 cases is the number stated upon which these remarks are directly based, yet a much larger number of cases have been actually seen and recorded in my note-book. But these latter group of cases were not mentioned, simply because these records could not be completed, as the patients left treatment half way and were not heard of since.

As will be seen from a perusal of the body of the Thesis, the cases have been handled from a clinician's or a practitioner's point of view, and not that of a pathologist with any special knowledge and opportunity for the study of the pathology of Diabetes in a properly equipped laboratory or in the *post mortem* room. But as rational treatment can only stand on some knowledge of the pathology of the disease, this has been dealt with as much as lies in the power of a clinician with a small laboratory arrangement.

According to all recognised authorities on the subject, the principal treatment of Diabetes, as far as it is at present known, consists in the proper regulations of diet. This has been indicated in broad outlines on the basis of rational pathology of the disease, as far as it is known up to the present time, with minor helps from drugs and other therapeutic measures.

The important subject of *metabolism* is being minutely worked, and now in all its departments, except perhaps the special department which most concerns us, namely, "Metabolism in the Tropics." On account of the external heat of that climate, this metabolism is so different and special there as compared with the metabolism of colder climates, that it can account for many of the peculiarities in the habits and histories of the races living in Tropical climates.

The present age is an era in which physical chemistry has revolutionised scientific ideas both in the organic as well as in the inorganic world. And there have been great workers in the field of metabolism, such as Von Nöördan in the Continent, Dr. Pavy in England, Folin and others in America, and many other eminent workers elsewhere.

Of all the grounds for hope for successful treatment of this disease by any agent which may be called a drug in some sense, is in the new and promising science of Organo-therapy, or the most rational method of the treatment of diseases by the administration of the extracts of certain glands within the body itself, which are Nature's manufactories for manufacturing the things which inwardly remedy Nature's distemper. In the case of Diabetes—Pancreatic Extracts, and Duodenal Extracts, and Thyroid Extracts are being tried with some promise of success.

The other rational method of treatment which are also of great help in alleviating the sufferings and complications of this disease, and which as *the* rational method, for the future, will displace drugging and other crude methods of treatment in all fields, is the method of Vaccine therapy, which is now making such rapid progress every day.

And lastly, the general tendency of the healing Art now-a-days is that it is driving more and more towards *prevention* rather than *cure*. This prevention is a far more efficient and economic method than cure itself, for it prevents the evils from beforehand, *viz.*, the sickness and its attendant sufferings, financial and bodily, as well as mental anxiety and distress.

That it is so very prevalent among the educated middle class of Bengal is a very significant phenomena indeed, and must have for its cause something deep down in the peculiar position of the people—their physical and mental conditions and those of their surroundings, such as—

I. Their food—
    (1) which is very largely starchy and saccharine, and
    (2) greatly deficient in proteid nourishment.

II. Their peculiar social conditions, such as—
    (1) early marriage, and
    (2) endogamy,[1] *i.e.*, close in-and-in breeding or caste marriages.

III. Their peculiar work in life, which is—
    (1) arduous and anxious brain work, and
    (2) sedentary life.

All these factors have combined to render them so susceptible.

A Thesis on Diabetes.

LIST OF PAPERS SUBMITTED.

I *Thesis on Diabetes.*

Part of it read at the Exeter Conference of the British Medical Association, synopses of this have been published in the *Lancet* and *British Medical Journal*, and other papers (Tropical Diseases Section).

II. *Effect of Regular Muscular Exercise on Sugar Elimination in Diabetes.* ("Tropical Diseases Journal," London).

III. *Oxalate of Lime in Pregnancy* ("Calcutta Medical Journal").

IV. *Cast and Albumen in the Urine—their combined and separate Significance* ("Calcutta Medical Journal").

V. *Raw Meat Juice in Malassimilation of Children* ("Calcutta Medical Journal").

VI. *Meat Foods—their Varieties and Use.*

VII. *Weight in Sickness and Convalescence—Male and Female Subjects* ("Calcutta Medical Journal").

All these are in connection with *metabolism of the human body.*

INTRODUCTION.

In the following pages I have tried to set forth my views on the subject of Diabetes—a disease which has interested me deeply since the year 1899. It is extremely common in Calcutta, especially among people and patients whom I have often to deal with. In my opinion no less than 15 per cent. of the people of the educated class suffer in Lower Bengal. This fact is both scientifically as well as socially very significant. For this reason I commenced keeping records of all such cases I came in contact with, either my own patients, or those of other doctors whom I know, or my friends and relatives, among whom there is a large number affected with this disease.

I have done so with the help of a small laboratory especially meant for clinical urine analysis. As much accuracy, as I am capable of, has been sought after, and with as much continuity of record as a class of unsteady fluctuating patients will permit, has been secured. Very often records kept well for some time became discontinuous, because the patient left temporarily or for good. In this way I have tried to settle some of my ideas in this connection, in the light of knowledge derived from the works written by authorities on the subject, some of whose opinions, I am sory to note, grossly go against those of others of equal position.

What has concerned me most are only those points which are of use to a practitioner, the aspects which are of *clinical interest*. In other words, most of the opinions, passed or referred to, are the opinions of other authorities, only I have tried to verify them, and either found them supported or contradicted by my experience in practice.

I am giving here a few of these facts as observed by me, and points which I consider to be of very great importance in the tackling and management of the disease as a practitioner.

SOME IMPORTANT PRACTICAL POINTS.

1. There is always a *threshold of assimilative power* for carbohydrate, both in the healthy, as well as in the diabetic. There is always a definite limit for all, only in the diabetic it is much lowered. Ingestion, beyond this, leads to its excretion in urine as sugar. *Vide* Appendix.

2. The effect of giving carbohydrate food in *excess* to a diabetic—

It is passed out in the urine, and this continues for some days, and in the total, a greater quantity is thus eliminated than was given as food, *endogenously produced* by tissue breakdown, as a result of toxic action of sugar in the blood. *Vide* Appendix.

3. The effect of withholding carbohydrate to such an extent as to render urine sugar free early in its onset—

The lowered carbohydrate assimilative power is slowly raised, and restored in the more favourable cases, when, even allowing a greater amount of carbohydrate food, it is not passed out with the urine. *Vide* Appendix.

4. The evil consequence of continuing carbohydrate in excess in diabetes is to convert '*simple diabetes*,' that is, when the sugar readily disappears, by disallowing carbohydrate food into '*composite diabetes*,' when even by withholding all carbohydrates in food, sugar in the urine still continues as the result of tissue breakdown caused by sugar in the blood acting as a

toxic agent will do on tissue cells, lowering their power of resistance, and degenerating or totally breaking down (cloudy swelling or necrosis).

That sugar can be endogenously produced within the system is proved by '*Phloridzin glycosuria*,' in which a molecule of albumen splits up into urea and carbohydrate; for one gram of urea there are 2·8 grams of carbohydrate (Minkowski).

5. This last condition constitutes the real danger of diabetes, when—

(1) Sugar becomes permanent.
(2) Hyper acidity of urine, and increased urea elimination appears as the result of tissue breakdown, constituting the danger of *acedosis* of blood, and liability to diabetic coma.
(3) Gradual and steady diminution of body weight as far as muscles go. *Vide* Appendix.
(4) Greatly diminished resistance of tissue cells to inroads of micro-organism, *e.g.*, streptococci (gangrene carbuncle) and tubercle. *Vide* Appendix.

As has already been said, there is always a threshold of carbohydrate assimilative power even in the healthy.

Glycosuria is an intermittent symptom, due to temporary functional disturbance of this power. 'Simple diabetes,' otherwise known as digestive, can be checked by diet restriction, but 'composite diabetes,' which ultimately develops as the result of early neglect, is almost uncheckable and dangerous, and should be, from the very onset, guarded against, by diet restriction and treatment.

HOW CAN THIS BE DONE?

The Pathology of 'Glycosuria.'

By physical law, sugar must pass out in the urine, if sugar be allowed to flow free in the blood (diffusion and osmosis—Pavy). The fine particles of a crystalline substance in solution are always more or less diffusible, unless embodied with, and protected by, some coarse-grained coloid substance, like proteid. Dr. Pavy believes that grape sugar, which is the product of carbohydrate digestion, never remains 'free' in blood plasma, in normal condition, but after digestion is immediately taken up by the leucocytes, produced in the villi of the intestine, and is carried by them to the general blood stream, embodied safe within their thick coloid structure. This is the object of normal "leucocytosis after meals." The glycogenic function of the liver is a secondary provision against preventing the access of free sugar in the blood.

When an excess of sugar is introduced into the blood, either due to excessive ingestion through food, or rapid conversion of glycogen into sugar in the liver, as may be experimentally brought about by puncturing the fourth ventricle, or sectioning the spine, or vermiform process of the cerebellum, or cutting the splanchnic nerves, when a large quantity of blood flows into the liver by vaso-motor disturbance, 'hyperglycœmea' in the liver is also produced, and sugar flows into the urine (glycogenic theory of diabetes)—though temporarily.

On the other hand again, there may be excess of sugar in the blood, brought about by deficient combustion in the muscles and organs. The pancreas has an internal secretion, which helps this combustion of sugar in the muscles (Lepine). In disease of the pancreas there is glycosuria in consequence. The extirpation of the pancreas leads to the same result, but not when a small portion is left to continue yielding the internal secretion, or when another pancreas is engrafted. This theory of the origin of diabetes is steadily gaining ground. Most people that die of diabetes show marked changes in that organ-fibrosis, and atrophy being met with in nearly three quarters of cases.—*Albutt.*

On the other hand, in regulated muscular exercise, when the consumption of sugar is facilitated in the blood (*vide* my article on 'Regulated muscular exercise on sugar elimination in diabetes,' Journal of Tropical Diseases, Vol. 1907, also Appendix), the quantity of sugar is greatly diminished for the time being. This shows that glycolysis has as much to do with diabetes as glycogenesis. That the respiratory quotient is diminished in diabetes, is also suggestive, Co_2, diminishing $\frac{Co_2}{O}$ = less than normal (Von Noorden). Treatment by pancreatic extract and dusdenal extract is suggested on this ground.

It has been shown that diabetic blood serum, or urine, injected into a rabbit, produces marked disturbance, and that in case of actual diabetic coma, such blood or urine kills the rabbit. This proves the existence of some toxic agent in the urine and blood, but it is neither the sugar circulating, nor the higher acidity only, because these alone when injected will not produce so much disturbance.

RAW-MEAT JUICE IN DIABETES.

I have indicated one aspect of diabetic treatment above, namely, by the diminution of carbohydrate food, to as low a quantity as would render the urine sugar-free. This can be easily done in early cases, by the method recommended by

Pavy in his treatise on diabetes, and approved by Albutt as well. The only feature of that diet is, that meat preparations are given, and all carbohydrates stopped, for seven days. The quantity of glycogen, already stored up in the liver, as the result of previous carbohydrate ingestion, is quite exhausted by that time, and the liver becomes glycogen-free. Then commencing and slowly increasing the carbohydrate in food, till sugar just reappears in the urine, we determine the assimilative capacity for carbohydrate, of the person in question. Now, allowing a little less carbohydrate, it is perfectly safe for him, and the urine remains sugar-free.

This early precaution itself improves his condition by an innate effort of nature, and his power slowly returns, when a larger dose of carbohydrate may be tolerated. But to reach the normal level is generally an impossibility.

Another most rational and most important method of dietetic treatment of diabetes is by raw-meat juice, or serum-albumin, freshly drawn if possible. Rawmeat juice, which is almost the same thing, is far more convenient. Whenever it was properly administered to a diabetic, the benefit was marked. It is a highly assimilable proteid material, with certain normal principles in it (a product of the internal secretion of ductless glands of the healthy animal from which it is taken), which increases tissue tone. Muscles grew firmer, and a general sense of comfort and strength was felt, even when this dose was nominal, namely, ℥ii a day. Moreover, being highly proteid in nature, it will increase the power of carbohydrate assimilation in a diabetic. The best explanation of this is that the glucose—the product of carbohydrate digestion—is best carried embodied with proteid in the structure of the Lymphocytes, of the intestinal Villi (Leucocytoses after food), and not in a free state in blood. So also starchy seeds richer in proteid are better assimilated in this disease. Thus it is a matter of common experience that wheat containing 14 p.c. of proteid is better assimilated than the starch in rice which contains only 5 p.c. of proteid. It is partly on this ground that Dr. Pavy recommends almond food as a better food for diabetics, as also on account of its containing little or no carbohydrate. The soluble milk proteids, such as Plasmon, Senatogen, and the like substances, being the best of all.

Though I could not satisfactorily experiment on many of our people for a sufficiently long time, at a stretch, from what I have seen, I believe that this is a most rational method in the early treatment of diabetes. The stuff serves both as a nutrient as well as a medicine; the highly assimilable serum-albumin and muscle-plasma serving as food, and the unknown internal secretion contained therein, as medicine in malassimilation even when taken in small doses. One fact is quite evident, that the patients retain better tone in every respect—in their muscles and nerves as well as in their vital organs generally.

THE DIFFERENCE IN THE EFFECTS OF DIFFERENT KINDS OF CARBOHYDRATES.

As regards the difference in the effect of the different kinds of carbohydrates, the effect is on the whole similar, only varying in intensity, according to the rapidity of their digestion and absorption. Thus grape-sugar given in food is the worst, because it is most rapidly absorbed and most rapidly excreted, causing marked troublesome symptoms (*vide* result of grape-sugar treatment of diabetes.—Pavy).

All mono-saccharides behave in this way, dextrose, levulose and galactose. Di-saccharide, like lactose and satcharose, which in the process of conversion into the mono-saccharose type requires time in the digestive tract, are naturally absorbed and eliminated slower, and for this reason also the trouble they cause is milder. Poly-saccharides, like starch and cellulose, on the other hand, takes still longer time and causes still milder trouble. In fact for diabetc food cellulose or green vegetables are prescribed as a substitute for sugar and starch, for that reason.

All the above mentioned classes of carbohydrates are absorbed as grape-sugar after digestion. Even honey which is sometimes allowed to a diabetic (so-called "levulose cure for diabetes") is no exception. Saccharose, if directly injected into the blood, passes out unassimilated as saccharose, but if it be given with food to a diabetic, it passes out as grape-sugar. This is the case with all other carbohydrates.

DRUGS.

In the rational treatment of diabetes in early stages, judicious restriction of carbohydrates, use of raw-meat juice every morning, regulated muscular exercise, are in the majority of cases capable of yielding satisfactory results, if the treatment is commenced early enough, and steadily persevered in for some time. In some cases under these conditions the sugar in the urine may be quite absent, and the patient is like a healthy man in all respects, attending his daily work, and feeling comfortable and easy, and even may live the normal span of life.

Opium.—In some other cases the urine cannot be made sugar free, even by moderate diminution of carbohydrate in food. In such cases opium in some form is of considerable help. It is a matter of daily experience how powerful an influence this drug has in diminishing the sugar in the urine in this disease. Its *modus operandi* is variously explained. Pavy, who recommends it very highly, attributes the effect to constriction of blood vessels in the liver (Vasomotor effect). In any case the glycogenic functions of the liver is strengthened, and the rate of transformation of this glycogen into sugar is considerably lessened. The effect of the diminution of sugar in the urine is well marked. But it causes troublesome symptoms, such as constipation, checking of secretions, sleepiness, etc. But just as in pain, so in diabetes, a large quantity of the drug is safely tolerated. Pavy recommends its substitute codeine, which is the alkaloid specific for this purpose, and is at the same time destitute of morphia and other alkaloids, which constipate and cause drowsiness. I prefer using this drug, and along with it some alkali water, or better still, mineral water, in the morning, to keep the bowels open and the secretions free.

There are many cases, especially those which are long neglected, in whom the urine cannot be made sugar-free by any means—neither by restriction of carbohydrate, nor by administration of opium, or any other drug. In such cases the best possible remedies should be tried, in every way, namely by means of diet, drugs and exercise, so that the sugar may be reduced as much as possible from circulating free in the blood, and thereby damaging the vitality of the tissues.

One very significant thing in connection with the restriction of diet should be remembered. As there is always a sharply defined limit, to indicate the 'threshold' of carbohydrate assimilation power, for each individual case, both in the healthy as well as in the diabetic, that limit should, as far as possible, be determined, and carbohydrates should be allowed accordingly. Absolute stoppage is harmful in many cases, and is not always necessary.

The following conditions should guide us in this direction :—

(1) If the carbohydrate assimilative power be indicated by (ii) and only (i) is allowed, loss in weight is likely to follow.

(2) If, however, more than (ii) be given, say (iii) for one day, not only the excess of (i) will come out in two, three or four days, but the total amount thus passed should be greater than (i), as the result of tissue break-down, by the toxic action of sugar in the blood. But it is always safer to keep below.

(3) Then, again, what sometimes happens is a highly interesting fact.

If to counteract the loss of weight in diabetes, carbohydrates be increased, as is sometimes done by doctors, under the misconception that the weight will thereby go up, the real issue of such a procedure is a more rapid diminution in weight (*vide* Appendix). In such circumstances, the most reasonable course is to cut off carbohydrate still farther, when the sugar in the urine immediately diminishes, and very often the weight is found to go up.

After some time of abstinence in this way, the carbohydrate assimilative power is slowly restored, and then the body weight is found to *go down* again, because what the system has demand for, now, is not supplied in proper quantity. This would serve as indication to allow some more quantity of carbohydrate, and it is found that it is well tolerated.

Some believe that too much restriction of carbohydrate predisposes to the production of acetone, and diabetic coma. This is true, when sudden restrictions in diet are made, by very largely cutting off carbohydrates, all at once. Under such circumstances, the production of "acedosis" should be guarded against, by administration of alkali, and in a few days the system will tolerate the new diet.

There is no drug so sure in its effect as opium, or its preparations. But other drugs are also employed, either for diminishing sugar, or for counteracting complications, or relieving troublesome symptoms.

Alkali and Mineral Water has already been alluded to; it promotes the action of the bowels, and re-establishes secretions, such as sweat and saliva. Besides alkalies are useful in preventing 'acedosis' of the blood. Citrates of Potash and Soda are also useful in this connection, and lemon juice is excellent for this purpose, as well as for allaying the thirst as a delicious drink.

Of *Mineral Water* suited for diabetes, Vichy contains Sodi Bicarb, and Contrexville Calcium Carbonate, while Carlsbad containing Sodi-Sulphate acts as a good aperient. The best way is to change from one to the other, as otherwise the effect fails.

Arsenic taken for a long time, in small or moderate doses, so as never to produce any physiological symptoms, has been found to diminish sugar. The *modus operandi* is probably by promoting the consumption of sugar in the muscles. In many cases I have tried this along with, or separately from, opium. To begin with Fowler's solution in 5 minim doses twice after meals is well borne and useful, or a pill containing Arsenicus Acid or Sodi Arsenious or Ferri Arsenious in small and increasing doses commencing from $\frac{1}{50}$th, and rising up to $\frac{1}{12}$th, twice daily after meals. *Vide* Appendix.

One of my cases was remarkable for its rapid response to arsenic. A female aged 55, suffering from diabetes (her husband had it before her) for the last ten years, and with extensive eczema in the genital, and in the flexor aspect of the arms, rapidly got cured of this trouble after taking 15 drops per day for three weeks. The sugar in her urine was also decidedly diminished (nearly half): she is still contining the same treatment, with great profit.

Liq. *Auri et Arsenici brom* is largely used in old chronic diabetic cases, and it seems to act at least as a tonic in those cases very satisfactorily after long-continued use.

Calcium sulphide is used by some with the idea, that as a large quantity of Calcium passes out as Calcium Phosphate in the urine, by hyperacid blood dissolving away Calcium salts from the bone, it is meant to replace it. But this is of doubtful value. The best procedure in such a case should be to administer alkali, to diminish the hyperacidity of the blood. It may have some influence on furunculosis; or sulphur may act as an intestinal antiseptic.

Makaradhwaj, an aurvedic medicine consisting of sulphide of mercury prepared with gold (catalytic action), acts as an excellent tonic, and hepatic stimulant, and intestinal antiseptic too. It can be kept on with opium very well, and is undoubtedly serviceable in many ways. It does not actually contain gold. The heavy metals like gold and mercury are believed to be efficacious in checking the intensity of senile waste, as well as that due to disease. They long settle into the tissue, specially in the nucleus of tissue cells for which they have strong affinity, and thus stimulate cell reproduction; and also as a damper of rapid metabolism prevent wasting. Moreover it is a powerful medicine against Bacilus Coli to which vegetarians are so greatly liable.

Silajut is a pasty organic product from the minerals (it may be like Ichthyol, the component part of a fossil animal). It is very highly spoken of in Hindu system of medicines; but I have had little experience of this drug. It is costly, and difficult to get.

Bromide is given as a palliative for sleeplessness due to frequent micturition at night; sleeplessness is one of the most potent causes of the sense of fatigue and prostration we so often meet with in a diabetic. To counteract this, Bromide may be given with belladona at bedtime. Or a dose of Codine in increased quantity at bedtime.

Belladonna Extract is given in ¼ gr. doses or more, and is used with opium, both as a laxative, and nervous sedative, as well as for checking frequent micturition at night. In this way it is highly useful in combination with opium or bromide.

Trypsogen Tabloid is used to stimulate or replace the lost internal secretion of pancreas which is believed to influence the consumption of sugar in the muscles (glycolytic help). In some cases it does great deal of good.

Phosphoric acid has been found useful in some cases of nervous origin. It is some use in cases with marked sexual debility and mental derangement, specially when used with strychnine or nux vomica.

Ergot is given with the object of contracting the blood vessels of the liver, and thereby preventing the rapid transformation and carriage of sugar in the blood.

Phosphate of soda is of some use probably by acting as a cholagogue, by which the intestine is rendered aseptic by the antiseptic action of bile.

Eucalyptus oil, or fresh leaf infusion of it prepared like tea, at times shows a remarkable improvement in early cases (Medical Annual, 1905), probably by its antitoxic action on the intestinal mucus membrane.

These drugs afford strong presumption of the theory that diabetes is often of alimentary origin—or like many other diseases a product of auto-intoxication.

Antipyrin is used with the idea that diabetes is of nervous origin. Antipyrine Aspirine Bromides have been found of great use in nervous cases with worry and mental disturbances.

Strontium Bromide is both a nerve sedative, as well as used for some specific property of strontium.

Chlorate of Potash and *Hydrogen Peroxide* are used to supply plentiful oxygen to the tissue cells to help the oxidation of sugar in the tissues.

These and other medicines may serve as palliatives in various ways, but they cannot be compared in efficacy to Opium, Arsenic, and Alkalis.

Oxygen inhalation has been tried with some benefit. It helps the oxidation of sugar in the blood, and increases the tissue tone. Fresh air and outdoor exercise are helpful in this way.

Jamboline is a frequently tried medicine for this disease, generally in the earlier stages. It is an astringent. Some people confess having derived marked benefit from it, at least for some time (Noordan). My experience is not very favorable with this drug as a curative, but it is slightly helpful in lessening dieuresis.

Tryptase or *Trypogen tabloid* is being tried nowadays with the idea that this ferment will indirectly stimulate specially the internal secretion of the pancreas, which is believed to influence glycolysis in the muscle. Similarly extracts of Thyroid gland and of liver are also given. But opinions are not settled about their value.

In future, with further development of Organotherapy and Antitoxin and Vaccine Therapy, a valuable method of treatment is likely to come into existence. For these are the most radical and far-reaching and the most rational and thorough methods of treatment seen in nature, where the living organism is asked to manufacture its own medicine, and achieve its own cure.

Thus if an impartial survey be made over a course of records carefully kept for sufficiently long time, it becomes evident that it is a disease produced by various causes, and under various conditions, *i.e.*, may be of digestive origin, or hepatic or pancreatic, or nervous or muscular. Thus different cases are benefited by different drugs and lines of treatment. More than one cause may, and frequently do, act at the same time. But I believe that in its early stage and origin, intestinal toxæmia plays a great part, which gradually upsets the balance of other organs, *e.g.*, the liver, the tissue cells, the nervous system, and thus gradually complicate the disease and render it graver. That is why so much attention is necessary to be paid to diet and feeding. Small quantity of nourishing food sufficiently proteid in nature, well masticated and taken at shorter intervals, without overloading the digestive tract by bulk, and upsetting the liver, and hampering the excretory organs, are so useful, specially in early stage—preventing the disease from assuming a graver form.

DIABETIC URINE AT DIFFERENT STAGES OF THE DISEASE.

Reports of analysis of urine in diabetes in ordinary uncomplicated cases generally agree with each other in the following points. (The following remarks are based on the report of 200 well-selected cases which have been early in their onset to and continued late.)

1. Specific gravity in more than three quarters of the cases is above 10.20. Specific gravity may be very low, but still sugar may be present. These cases are rare, and generally occur with chronic interstitial nephritis, where urea elimination is greatly diminished, and sugar is also low or disappearing, yielding place to trace or more of albumin or some other deleterious products.

2. Acidity of the urine is generally in excess, and that is why in spite of a pretty large quantity of phosphates being present, deposit of phosphate in fresh urine is seldom seen.

3. Ordinarily Albumin is only found in about $\frac{1}{10}$ of the cases in the earlier stage. It is mostly met with in chronic cases and not in acute ones, even though the quantity of sugar passed by the latter is pretty large. Its occurrence in other words depends more upon the duration of ailment than upon the quantity of sugar. This albuminuria is probably due to

Arteriosclerosis caused by sugar long circulating in the blood, and acting as any other toxic agent (scarlet-fever, mercury, etc.) will do to bring about such changes in the kidney. *It is very interesting that proteid food does not increase albumin in the urine as sugar does sugar, in diabetes.* (*Vide* Appendix.)

4. Casts are still less often seen in the early stage, and when seen are mostly of hyaline and hyalogranular nature, just as is observed in chronic interstitial nephritis.

5. Urea is always more or less increased. The *normal elimination of urea in Bengal is a little over half the amount* (250 *grs.*) *mentioned in European books* (500 *grs.*). (*Vide* Appendix.) The reason is our vegetarian diet, deficient musculature, comparatively less active life. In diabetes this urea is as a rule greater, and must be due to slow breakdown of tissues, by the toxic action of sugar. Ammonia urea and total nitrogen have their relations disburbed whereby NH_4 increased.

Carbohydrate food for this reason *relatively increases* rather than diminishes urea in a diabetic at times, although in normal health it does the reverse. This anomalous result is due to additional toxinic breakdown of tissues by the resulting increase of unassimilated sugar in blood. (*Vide* Appendix.)

6. *Acetone.*—Oxybutyric acid, diacetic acid and acetone are frequently present in minute quantity, in cases where the hyperacidity is marked. Of these each earlier one indicates a graver condition than the next. The best and the easiest test for ordinary clinical purpose is with Nitro-prusside and hydrate of sodium for acetone and ferric-chloride solution for Diacetic acid. Its presence often, though not invariably, indicates "Acedosis" in the blood, causing suspicion of imminently threatening "coma."

The blood in such cases becomes less alkaline. These acids in the blood appropriate the alkaline bases in the blood which would have carried Co_2 in combination; Co_2 therefore accumulates in the blood and brings on "coma," with its peculiar air hunger and sighing breath, fruity smell and somnolence. Any other acids, injected into the blood, will produce similar symptoms, in a similar way. This is a grave condition, and the only rational method of treatment in such cases is to alkalise the blood and dilute and eliminate the toxin by saline injection with alkali.

8. Octahedral crystals of Calcium Oxalate which is otherwise so common in Lower Bengal (nearly ⅓ among vegetarians—*Vide* Appendix) is comparatively rare in diabetics. The probable reason is, that although the urine often contains more than the normal quantity of Calcium owing to its higher acidity dissolving bone salts, it is probably in combination with the other acids as Phosphate, Carbonate, and not with Oxalic Acid. The latter is perhaps produced in smaller quantity in this disease, as

digestive function in this disease is generally hyperactive, to supply the waste of valuable material that is going on in the urine, and acid or fermentative dyspepsia is rarer, but "roaring appetite" is commoner instead.

Dr. Cumming explains the origin of oxalate from Pancreatitis, or inflammatory condition of the pancreas, while that of diabetes from its fibrosis and resulting atrophy. He believes that oxaluria is a preliminary symptom of diabetes. But sometimes it alternates with sugar.

Uric acid is less common among us than among meat-eaters, evidently on account of our food being largely farinaceous, but in diabetes it is found more frequently, either as a result of the changed diet which is often prescribed (exogenous origin) or as a result of rapid tissue-waste (endogenous origin). It is found even in those that have not changed their food but are undergoing pretty rapid loss in body-weight. But these suffer less commonly than those who substitute meat diet. The late Dr. Crombie used to say that diabetes is the Gout of Bengal. Evidently he meant, that instead of the effete material being deposited in the joint, it is eliminated as sugar. Many authorities do not believe in any connection between gout and diabetes, on the ground that whereas one is a case of defective nitrogenous metabolism, the other is a case of defective carbohydrate metabolism, the one is a faulty *excretion*, the other is a case of faulty assimilation.

ADVANCED STAGE.

In chronic advanced stages the changes in the urine is significant, and just as should be expected. Albumin appears generally in small quantity. Casts in many cases.

Sugar often diminishes spontaneously, yielding place, as it were, to albumin.

The specific gravity falls in consequence of diminution in *urea*, which latter is often considerable, with the advent of chronic interstitial nephritis, threatening uraemia and other disorders.

The bladder shows evidence of crystitis, and pus and a large quantity of phosphates, mucus, and epithelium, and ammoniacal urine, make their appearance. Sometimes death takes place by suppression of urine, with twitchings and irritation, more resembling uraemia than diabetic "coma" with its air-hunger and sighing respiration and sweet smell, but the latter is by far the more common.

Another extremely interesting and significant change in the urine is observed in certain cases of threatening complication, which are generally serious, and often fatal, and silently brewing for some time before it appears. There have been many cases (*vide* Appendix) in which the quantity of sugar spontaneously diminished, or disappeared altogether, and then either

(1) lung mischief (pneumonia, pleurisy), or
(2) gangrene of the extremities, or
(3) carbuncle

developed.

In these seats of lesions, the sugar undergoes consumption, probably fermentative decomposition, and consequently disappears from the urine. Such diminution also happens in cases of diabetic "coma." (*Vide* Appendix.)

These cases are almost always fatal. But immediately before I left India, I saw an old patient of mine recover in a remarkable manner. He was a bulky young man, a huge eater, and with a large quantity of sugar (gr. 30 to oz. i), with 200 ounces of urine per day in his urine, for years and years. A year and a half ago he had an acute attack of pleurisy, and the sugar from his urine totally disappeared. Fluid accumulated in the pleura, and cough and expectoration followed with evening hectic, and all signs of tuberculosis. But after a year's suffering, he quite recovered, as far as external signs were concerned. There are no local or general symptoms; he has got much leaner, but is doing all his work with energy and good spirits. *The sugar in the urine did not return.*

METHODS OF PROCEDURE.

Methods of procedure in connection with analysis and treatment are naturally of considerable importance in connection with the facts observed in the cases. But most of the cases which have begun well, and have grown impatient for diet restriction, either change doctor or change the system of treatment, or do as they like. In those cases, however, where satisfactory records could be kept for any length of time, I had their urine generally examined every week or fortnight, and, in exceptional cases, oftener.

The urine passed at bed-time about two hours after meal, and that on getting up from bed in the morning were separately re-collected, so that I could test the urine after meal, and that of the empty stomach. Slightly different results were obtained in the two examinations; the night-urine generally being of a lower specific gravity (specially if he drank largely), and less acid, due to "alkaline tide" after meal, and containing a greater amount of sugar than the morning-urine, all on account of the ingestion of food shortly before.

A 24-hours' secretion was collected from time to time. But in other cases the patient was asked to keep a note of the total quantity, and only one sample was analysed and the total calculated. In the same way, a note was kept of the diet taken, or of any special food, or circumstances, which might affect the urine.

Sugar was estimated with Fehling's solution, modified, as Pavy has suggested, with an excess of Alkali added, and some quantity of ammonia to dissolve the brick-red precipitate, which mars the exact colour.

Albumin was ordinarily estimated by filtering, heating, and adding a few drops of acetic acid and taking the sediment after some time. In most cases Esbach's method was followed, the difference being slight. Urea was estimated by Dorimu's Ureometer, the reading being taken after 24 hours, and a countertest or "control" being done at the same time. The urine was always boiled and filtered before.

Acidity, where it was markedly in excess, was estimated by Decinormal Soda Solution and Phenolthalien. It cannot be done in the ordinary way for estimating acids, as the acidity of urine is not due to free acid only but acid salts as well. But occasionally free acids had to be separately estimated.

Acetone or its predecessor diacetic acid was frequently carefully tested. The former by the well-known Nitro-prusside Test, and the latter by the Ferric Perchloride method. Iodoform reaction was also done. It appears in many diabetic and other urines as well; more or less in bad cases there is always some "acedosis" with heaviness and malaise, but "coma" does not necessarily follow in all cases. The system, however, is so predisposed to coma, that the least exciting cause may bring it on. I know of a case which got it after sea-bathing and swimming. Both cold and fatigue bring it on.

In this connection one other remark must be made, and that is that urine by keeping, specially in hot weather, gets the amount of both sugar and urea somewhat diminished due to fermentative decomposition. The former in some cases diminishes 5 per cent. by turning into alcohol, and the latter more by changing into carbonate of ammonia. The samples of urine that are sent from abroad are often misleading on this account, unless they are treated with some antiseptic such as urotropin or boric acid gr. v to ʒi, or formaline or carbolic acid of which about ten drops in a bottle of eight or ten ounces well shaken will preserve. This much about analysis of urine.

Something must now be said about the diet and habits of the patients.

DIET.

The difficulty one experiences in treating this disease, among a class of patients who are habitually vegetarians and rice-eaters, and very fond of sweets, and very loath to take animal food, can better be imagined than described.

If, where necessity so requires, they be asked to stop rice altogether, and take meat, the patient, as a rule, after a few days' trial, leaves. In all such cases, some concessions should be, from the very start, made, and the screw gradually tightened, if necessary. All saccharine substances should be at once stopped, but some form of starch sparingly allowed. Instead of taking rice in the morning as well as in the evening, in the latter hour bread is substituted, in small quantity, and instead of allowing starchy and saccharine vegetables, green vegetables containing a lot of cellulose are introduced.

Undoubtedly the best is meat, if the meat be good, and nicely cooked. This is a great difficulty in meat-treatment among us, that in addition to the natural aversion, good meat cannot ordinarily be had, at a convenient rate, nor can meat be well cooked by our people. They cook it at too high a temperature, and with too much spices, and oily substance, which make it too rich, and difficult to digest. One who would treat this disease there, should also teach the simple art of plain cooking as it is done in Europe, underdone, and taken with slight spices and salt. The complaint against the meat-diet in our country is all due to bad management of the kitchen. Simple grilled or stewed meat, or minced meat made into chops, various preparations of fish and egg, together with sparing use of carbohydrate, may keep the patient perfectly well, and contented, when variety is judiciously introduced.

I am so highly impressed with the value of cutting off carbohydrate to a considerable extent, and substituting proteids instead, *i.e.*, introducing a quantity of easily assimilable nourishment in small bulk, that I began giving raw-meat juice in all cases where they would take it, regularly four to six ounces in the morning, and was highly impressed with the benefits derived in this way (*vide* Appendix).

But diabetic patients are generally voracious eaters, and crave for bulky foods. For this reason, some brown bread and green vegetables may be allowed. But if these be forcibly withheld for some time, the hankering for bulky food, due to a sensation of emptiness, and not of hunger proper, will in time disappear, and the case will do much better than by distending the alimentary canal with these stuffs.

The next necessity is some stuff to sweeten. For this purpose various things are given—honey, glycerine, saccharine. Both honey and glycerine bring on sugar. Of course glycerine is a lesser evil (Pavy). Saccharine is the safest to use.

After bulky food and sugar, the third demand is for some sort of delicious drink to allay the insatiable thirst.

MILK.

Milk diluted may be given but sparingly, as the lactose is excreted as glucose. The best preparation of this, from every standpoint, is " butter-milk, whey," "dai." The ancient Hindu system of medicine highly recommended it as a soothing and agreeable drink, and also as a food and a medicine, in this disease. In modern days, it has got many scientific supporters. Mitchnikoff in his " Nature of Man " recommends it as a specific against intestinal fermentation, the poisonous product of which, being absorbed into the blood, cause arteriosclerosis, and bring on old age earlier. Being acid, this whey promotes salivation, and allays thirst. Other preparations from milk are Koumis and Kafir, in both of which sugar is changed by fermentation. They are very suitable but difficult to prepare.

The next drink is plenty of lime juice in water : it is also acid and agreeable to taste, and the Potash citrates and other stuffs contained there are excellent alkaliers of blood and urine.

CARBOHYDRATES.

Now to the detailed consideration of carbohydrate food.

As I have already said, rice is the worst. Ordinary white wheaten bread is better; wholemeal bread is better still. Gluten bread, brown bread, and almond food are best of the whole lot. In judging about these, two things ought to be seen, *viz.*, the less the amount of starch, and the greater the amount of associated proteid, bulk for bulk, the better and more suited the stuff is for being allowed in this disease. Starch from different sources are assimilable to a different degree. We should remember, that the form of carbohydrate is most easily assimilable which is associated with a pretty large element of proteid. For carbohydrates after digestion are carried in the blood, not dissolved in the plasma, as was heretofore believed, but embodied within the proteid tissues of the corpuscles, which are known as lymphocytes, from the intestinal villi, which immediately after food is digested pour into the general circulation, carrying the nourishment within them, this being the object of " Physiological Leucocytosis" after meals. These corpuscles are very unstable and dissolve away very soon after, yielding the proteid component to the blood, and the sugar to the tissues (Pavy). That these are very unstable is further shown by the fact that in the clotting of blood these degenerate first, commencing the development of the fibrin thread, from their substance.

The above is Dr. Pavy's idea, and I approve of it for the following reasons :—

1. He has actually shown the presence of carbohydrate in the Leucocytes.

2. Otherwise "Physiological Leucocytosis" has got no better explanation.

3. Why should these corpuscles be produced near the digestive tract, and flock into the blood at that particular stage, and then disappear by breaking up so readily?

4. It is a reasonable presumption, that as red blood cells carry oxygen loosely combined in their hæmoglobin, so these carry the other element which blood takes in from outside, namely nutrition.

5. Clinical experience actually shows that wheat starch containing a greater percentage of proteid is much better assimilated in this disease than rice starch which contains so little of it.

All authorities admit that proteid constitutes the most important element in food, which is meant to be built up into the protoplasmic structure of the tissues. If this be withheld, the animal dies with the symptoms of starvation, in spite of other food-stuffs being given to it. It is the chief component part which builds the muscles, which make the vital organs work. What wonder, then, that it will be such an important and indispensable food-stuff, the insufficiency of which must bring on many diseases, of which diabetes is one—its remote cause being traced to the insufficiency of the supply of proteid, in the building period of life (our vegetarian diet). The remedy can only be half successfully applied by beginning to give proteid, when the disease has developed in adults; but to prevent this disease, we must alter the dietary, in the growing period of life, by a large supply of easily assimilable proteid in the shape of animal food. That is also the rationale of raw-meat juice treatment, of which I entertain such high hopes on the ground of what I have seen, by trying it in all forms of malassimilation disorders. (*Vide* Appendix.)

Noordan speaks highly of "oatmeal cure." But others do not bear it out equally. However it is far better than rice or any other form of starch ordinarily used in our country.

HISTORY OF SOME OF THE CASES WHICH TURNED UP FAVOURABLY.

The guiding principles which I always follow in such cases are:—

1. To take the patient as early in hand as possible.

2. To let an intelligent patient be well convinced that such cases will take time, and nothing can be done in hurry or impatience.

3. To try to render the urine sugar-free if possible, by simultaneous precautions from all sides, if necessary, namely—

from restrictions of diet, regular exercise, raw-meat juice, where practicable, and administration of medicines according to the supposed nature and origin of the disease.

4. For the first few days, trial is often given by natural means, by curtailment of carbohydrate, and regular exercise, preferably in open air.

This also helps us to judge approximately his carbohydrate assimilative power, and regulate the treatment accordingly.

5. Always guard against *bulky* food, by advising simply cooked animal food, like underdone meat, fish, eggs, cheese, almond, plasmon, and some of the other stuffs poor in carbohydrate.

6. Always insure sleep at night. This is very important, as a nervous sedative, and if necessary by giving Belladonna and Bromide at bedtime, to check excessive urine and soothe the nerves at night. Or Aspirin Hyosene or a bigger dose of codine or opium may be given: sleep is very important for diabetes.

7. Guard against cold and fatigue or overwork: this often acts as the exciting cause of coma.

8. In favourable cases the urine is examined once a month, in others oftener.

DIET.

Choose between—

Morning.—Eggs lightly boiled or poached, wholemeal, toasted bread with butter, cup of hot diluted milk, with or without tea. Take a light diet well masticated.

Noon.—Grilled or stewed or minced meat, three or four ounces bread, green vegetables, baked potato (containing Potash it is useful against "Acidosis"). Or wholemeal bread and dal or small quantity of coarse rice, or better still the outer scrapings of rice known as *khood*.

Fruits.—Oranges, pineapple, cucumber, almond, apricot, pistas.

Vegetables.—Jhinga, uccha, thore, sak, dantā, natī, etc.

Drink.—Diluted milk, lemon juice, butter-milk, water, dai.

Night.—Fish, biscuit, cheese, diluted milk if thirsty, but not with tea or coffee. Very light diet.

Some form of physical exercise is prescribed, regularly in the morning after drinking a small quantity of hot water, to serve for washing the stomach, and to promote actions of the bowels. The best time for mild exercise is in the morning, half an hour after getting up from bed and after hot drink. This is also the most convenient time to spare for everyone. Its only drawback is that it is an indoor exercise. It would be better to follow it up by a short outdoor walk later on. This exercise, if in-door, is taken before food, if out-door, is taken some time after.

Sandow's regulated muscular exercise, with or without dumb-bell, before breakfast, with a short outdoor stroll after breakfast, is the best. Nothing should be done to fatigue.

Medicine—The following drugs are often used—

(*a*)	Codina Phosph	gr. i.
	Ext. Bell	gr. ¼.
	Ext. Nux	gr. ¼.
	Resin Podophylli	gr. ¼.

Make, one pill. Twice or thrice daily (only commenced if diet and exercise do not suffice to stop sugar in the urine).

(*b*)	Sodi Bicarb	gr. xxx.
	Spt. Amon Aromat	m. xxx.
	Ag. ad	oz. i.

Only in the morning, or twice or three times daily, as necessary (along with the above. if there is marked hyperacidity of the urine).

(*c*) Carlsbad—Morning when necessary (aperient).

(*d*)	Tr Belladonna	m. xv.
	Pot Bromide	gr. xx.
	Sodi Bromide	gr. x.
	Syrup Chloral	dr. i.
	Ag Ad	oz. i.

(At bed-time : if no sleep only occasionally).

(*e*) *Either*, Liq. Auri Ars brom .. m. v.
(with water after meals twice).

Or, Fowler's solution .. m. v.
(with water after meals twice).

Or, Makaradhwaj (sulphide of mercury) in the morning.

In some cases of moderate virulence in middle aged—

(*a*) Codina goes alone, with occasional help from
(*b*) Alkali, or
(*c*) Saline, and
(*d*) Bromide draught.

In old age—Lig Auri is given, as well as Codina.

In chronic trouble of middle aged, or young men, Fowler's solution, or Makaradhwaj, is given instead of Auri.

In cases of nervous origin—Acid Phosph dil mix. after each meal, or Aspirin, etc., answers well.

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When sugar disappears, with moderate regulation of diet and exercise, no medicine is given at all; or if it were given before, stopped and tried alternately.

When it does not do, instead of curtailing the carbohydrate excessively, introduce codina to help, regulating the dose according to necessity.

In no case should sugar be allowed to pass in the urine if it can be avoided, but codina may occasionally be stopped, or alternated with saline, or arsenic or gold.

In rapidly wasting cases Codliver Oil, Glycero phosphates and tonics should be given. Some cases remarkably improve by Codliver Oil and Iron and Strychnine. General health should always be carefully guarded.

Experimental heroic doses are always harmful, whether it be Opium or Arsenic or Antipyrin, or any other medicine. So is multiplicity of drugs. No miracle can be achieved, or short cuts made in this way. Steady, slow, and methodical procedure can be fruitful of as much good only as can reasonably be expected in this disease.

For treatment of minor complications, such as skin eruptions (pruritus) and boils, cleanliness should always be recommended. For major complications like gangrene, carbuncle, surgeons should be early consulted. Antistreptococus serum is useful in some cases of gangrene, and early incision in the others with it. No strong caustic applications are advisable. For P.P. or pneumonia, which rapidly turns into gangrene, there is no remedy except the ordinary procedures, namely, expectant treatment and for relief and support, and for diabetic coma saline injection with plenty of alkali water to drink, do something for the time being. But in all cases of inflammation, antistreptococus serum should be thought of, as the fall of opsonic index (or tissue resistance) is raised by it, for the time being, and sometimes chances are given for treatment. Vaccine treatment has opened a new and most valuable field. In cases of persistent boils and abscess vaccine treatment from beforehand averts many evils.

BOOKS CONSULTED.

1. Albut's system of medicine.
2. Tyson's book on albuminuria and diabetes.
3. Osler's system of medicine.
4. Pavy—"Croonian lectures on diabetes,"
   "Carbohydrate metabolism,"
   "Physiology of the carbohydrate," etc., etc., etc.
5. Von Noordans—"Diabetes," etc., etc.

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LIST OF FOODS SUITABLE FOR DIABETES.

Wholemeal, Bran, Gluten, Almond, etc.

Almost all of these contain more or less carbohydrates, but ordinarily that does not matter much, if the quantity be properly regulated.

They may be made into biscuits, cakes, puddings, bread, and many other more or less agreeable stuffs. They *are always less digestible and less palatable than any of our ordinary* food-stuffs.

Soluble proteid preparations of milk, like plasmon and similar substances, are now-a-days thought to be the most suitable. So is Sanatogen and similar other milk products. The best form of taking milk is as Dai, where the sugar is fermented into the most agreeable and highly digestive antiseptic lactic acid.

Cream and cheese are suitable, but milk very sparingly. Recently sugarless milk and foods are being manufactured by Cullard & Co., Regent Street, London: they are no doubt of some use. But no vegetable stuff suits so nicely as animal food in moderation, and all classes of the latter may be taken; meat, game, poultry, fish, eggs, but no liver or oysters. Quite a variety of preparations may be made from cheese, which is a valuable nitrogenous food. Sweets may be prepared with it mixed with *Saccharine*.

Lemon, oranges, pineapple, cucumber, tomato and green stuffs may be taken with impunity.

If potato is given it should be baked to retain its valuable potash salts, and never boiled.

PREVENTION.

At the last Annual Conference of the British Medical Association at Exeter, great interest was shown over the question:—

"*Why is the disease so prevalent among the educated classes in Bengal?*"

To my mind the causes are not far to seek. There is everything in their physique, diet, habits of life, and social surroundings which make them especially susceptible to this disease:—

1. Their staple diet is rice, and rice contains the largest amount of starch, 95 per cent., and the least proteid in it—5 per cent.
2. They neglect physical exercise and do excessive brainwork.
3. Their muscles are so soft and flabby on account of the want of a sufficient amount of easily assimilable proteid in their diet, which is especially injurious in the early building

period of life, thereby leaving for ever a defective development. Such poor muscles cannot possibly consume the large amount of starch ingested by rice, in the absence of sufficient muscular exercise. So that whether viewed in a "glycogenic" or "glycolytic" light they are found faulty, ingesting more sugar and consuming less, which causes its accumulation in the blood, which must pass out in the urine.

Therefore, effectually to prevent such a serious national evil amongst us, the remedy should be applied to childhood. By taking good care of the children in their growing period of life, we can prevent the development of diabetes, even in the offspring of people who have got hereditary tendency in the family. The most important aspects of this measure lies in the administration of sufficient quantity of proteid diet for the development of solidity of the bodily structures, *e.g.*, muscles and vital organs, by proper regulations of exercise, and fresh air. No food is so suitable for the building of the body in early years as simply cooked meat-diet, which is digested with the greatest ease, and builds up the solid tissues nicely. For people who cannot or will not take it, fish or eggs would be good substitutes. For strict vegetarians, milk and milk preparations, such as cheese, are excellent, provided they are got sufficiently pure and in sufficient quantity, which is very difficult to procure in the town. There are valuable stuffs in the vegetable kingdom as well, which are highly nitrogenous, such as dal, nut-foods and the like. But they are far more difficult to digest and assimilate. But they may be prepared and cooked in different ways, to make them easier of digestion, such as by minute pulverisation, and long and thorough cooking and chewing.

The above-mentioned foods and exercises, as have already been said, are also valuable for diabetic patients, but when the disease has developed in grown-up age, their efficacy is much less evident. If these steps be taken in the early building period of life the disease may possibly be prevented altogether, and certainly that is better than cure.

MEAT-DIET—ITS VARIETY AND USE.

Since proteid diet, or diet under the meat class, is very important in the earlier or building period of life, and in cases of debility from overwork and exhaustion, and during recovery from sickness, to enrich the impoverished blood, to increase strength and energy, and to restore the lost body-weight, the following facts on diet may be of some interest to the public.

Bone-marrow.—The first and foremost place is given to bone-marrow, which is so largely wasted at the butcher's shop. It is a highly concentrated nourishment, and the most valuable agent which enriches blood. It contains proteid as well as fat, and is a stuff of much higher nutritive value than raw-meat juice, but is less easily assimilable than the latter on account of its containing a larger quantity of fat. Besides it contains glycerophosphate, the component of nerve tissues and testicular secretion.

The thicker bones contain much fat, and this marrow is whitish in appearance, and is harder to digest. Softer and more reddish marrow, as in spongy portions of bone and ribs, is more suitable for invalids, and the thinner shin bones, are the best for this purpose. The marrow of mutton is richer and harder on account of its containing a greater amount of fat. That of goat is better, and of beef is the best.

Both marrow and raw-meat juice are highly cellular, the former containing marrow cells and the latter blood corpuscles, and on this account has a tendency to aggravate uric acid diathesis. Hence it is not suitable for people with gouty tendencies, or suffering from uric acid calculi. It is highly useful for neurasthenies, or run-down patients, with oxalate of lime in the urine, and especially for rickety children.

The best way of gathering bone-marrow is from the butcher's shop. The rejected long bones should be got entire, and after being washed thoroughly on the outside, should be split open, longitudinally, at home, and the marrow should be scraped out, and preserved in a clean covered vessel, surrounded with ice, and taken very soon after extraction. The best bone-marrow is situated inside the cancellous tissues, at the extremities of long bones and ribs; but these are very difficult to be extracted, and so are not considered here.

There are various methods of taking the marrow. It may be taken raw, or lightly cooked (fried, or made into thin soup). For taking raw the softest and reddest ones from the thinner bones are preferable. These should be rubbed down to a thick paste or simply spread between two thin slices of bread, adding, if necessary, something to it to sweeten it, such as jam or jelly or syrup, with the essence of veneal, lemon, or orange, and the like. The best method for very low and delicate patients is to paste it with agreeably scented syrup. After being cooled in ice, it should be given like jelly, especially where the stomach is irritable and nausea present.

Marrow, from thicker bones, as has already been said, is whitish, more stiff and more difficult to digest in a raw state on account of its containing a larger amount of fat. Such marrow is, however, better digested if taken slightly cooked, or made into a thick soup—thick on account of fat, which can be made thin by addition of pearl barley water. This is more nourishing, and more suitable for people who are particularly delicate, but who want it only as a restorative.

The best time to take these is in empty stomach, or after light food. It can thus serve as a restorative for overworked people, between meals, as in the case of people who have to take breakfast early, and who have to pass long intervals between meals.

People, like doctors, that take late breakfast, should take it in the middle of their morning work or fasting hours, clerks and lawyers in the afternoon. As has already been said, it is an invaluable medicine for enriching the blood, and increasing efficiency, and body-weight. The prepared tabloid of bone-marrow sold for this purpose are quite worthless.

Raw-meat juice.—The next place is given to raw-meat juice, which is squeezed juice of fresh minced meat, and consists of serum albumin and muscle-plasma, with a large number of red blood cells. It is very easily assimilable, and strengthening, and is widely used for invalid cases, specially for rapid tissue regeneration. It is a most favourable diet for malassimilation in children, and in phthisis, dyspepsia and diabetes. The most valuable and useful property which it has got is to help the assimilation of other foods in a rather inexplicable way. *In other words, a small quantity achieves a great end, something like enzeme action, probably on account of its containing some internal secretion from the ductless glands which healthily influences metabolism.*

Soups are meat extracts prepared by boiling. The boiling should be slow and long continued, and at low heat. Light broth has water added, but jug-soups are extracted without water. The advantages of the latter are their small bulk and concentrated essence.

Soups have very little nourishment in them, as all the soluble albumen are coagulated by heat, and left behind keeping the extractives, which are mostly waste materials—for this reason they act as stimulants. An increase in weight is not so often seen to take place by taking soups as by taking raw-meat juice or bone-marrow. But in wasting its gelatine saves tissue waste and it gives strength and energy to heart and digestion and indirectly helps nourishment. Moreover, soups irritate the kidney, and are bad for people suffering from kidney trouble. It is an excellent mineraliser of the system.

The extract of meat at a high temperature, or by long boiling, brings a large amount of gelatin, which is thick jelly-like substance solidifying when cold. As has already been said, in itself it is not of much nutritive value, but is like the waste materials, a highly powerful stimulant. Brand's essence of chicken, Leibeg's extract of meat, etc., belong to this class.

This is the way in which meat extracts are preserved: they are generally prepared from the rejected portion such as tendon, bone, etc.

Particular organs and tissues of the animal organism have particular therapeutic value. Thus:—

Testes.—Is a valuable nervine tonic and aphrodisic. It may be taken cooked or uncooked. "Uncooked" is the best form if taken fresh, either minced or sliced, and kept between two thin slices of bread, like sandwich, sweetened and scented if necessary. "Lightly fried" is the best cooked preparation. By boiling it loses the efficacy.

Brain.—Should be taken cooked, either boiled into thick soup, or boiled and sliced and taken between slices of bread like sandwich, or boiled slices may be fried with egg, like cutlet.

It contains a large amount of fat, and is difficult to digest. It is a nervine tonic of very high value, and an aphrodisic containing "cerebrin" and valuable glycerophosphates. The brains of fishes are more valuable, being more easily digested, but it is more difficult to procure in sufficient quantity.

Liver.—Contains a large amount of sugar (glycogen), and is fattening. It is always taken cooked. Sometimes oysters which have big livers with a large amount of sugar stored up, is preserved soaked in vinegar and is taken raw, like preserves. But these introduce a lot of extractives or purins to the system.

Fat.—Is fattening, and is very difficult to digest. It is generally used in cooking but seldom taken alone.

Egg.—Is the cheapest, the most convenient, nitrogenous food, and the most widely used. It is highly nourishing, and, when taken half boiled, is very easily digestible. The yolk is richer in fat. Taken raw, it is less easily retained in the system, as being different in nature from serum albumin it tends to pass out with the urine. But it is very convenient and strengthening when taken as egg flip. Hard-boiled egg is most difficult to digest. Poached egg in a little butter is very palatable, and is quickly prepared, and simple.

It may be beaten up frothy, and fried, and when thus prepared becomes spongy and soft, and thus easily admit the digestive juice, but is liable to cause acidity. Not being cellular, the white portion does not give rise to uric acid as meat does, and is thus the only form of proteid which can be given to people with uric acid diatheses.

Thyroid and Adrenalin glands have got therapeutic use, but none as food. So is Pancreas coming into use as a medicine for dyspepsia and diabetes.

Lastly, although rather irrelevant under this heading, I shall just mention, that for non-meateaters the following stuffs may serve as substitutes for meat—

1. Milk and milk preparations—*e.g.*, cheese, dai, etc.
2. Nut foods, such as almond, apricot, etc.
3. Leguminous fruits or grains belonging to the pulse class—dal.

But these I shall deal with in detail in a separate article.

APPENDIX.

The following headings are illustrated by cases below :—

1. "Threshold of Carbohydrate Metabolism" exists both in the healthy and in the Diabetic.

2. Endogenous production and elimination of sugar, when sugar is given in excess to a diabetic, is brought about by tissue breakdown, thereby rendering the case worse.

3. Restoration of this power takes place after lessening carbohydrate in food, and thus keeping the urine sugar-free for some time.

4. In Composite diabetes, steady diminution of body-weight, as far as muscles go, takes place by toxic breakdown of tissue.

5. The following is the relation of Diabetes to body-weight : (1) diabetic patients are generally "over-weight" ; (2) after the onset of the disease the weight in the majority of cases falls; (3) excessive carbohydrate given to a diabetic leads to more rapid diminution in body-weight ; (4) such allowance being lessened or stopped, weight first slowly goes up ; (5) if, however, now carbohydrate be kept lessened or stopped for a long time, weight again falls, although there is no sugar in the urine. This is due to re-establishment of lost carbohydrate assimilative power, which now naturally demands it ; (6) then an increased allowance of it will at once raise the weight up.

6. Of Carbohydrates—Mono-Saccharides—glucose, Di-Saccharides—cane sugar, Poly-Saccharides—starches,—these are all harmful when given in excess in diabetic conditions. Their elimination time, when ingested, is slower and slower, and evil effects less and less, in the order mentioned.

I. CASES.

These statements can be definitely verified in many cases strictly under personal control. The best way is to give measured quantities of pure grape sugar. Go on increasing the dose till distinct quantity of sugar can be detected in the urine. Here is a case to the point—

Case I.—A healthy adult male, a school-master, a man of strong build, was given 2 ounces of grape sugar with food. On the very next evacuation of urine after 3 hours he began passing sugar. This continued for nearly 5 days. The total quantity passed out was not more than $\frac{1}{2}$ the quantity given.

Case II.—The above case is with respect to a healthy man's limit of assimilative power. In a Diabetic this limit is much lowered. In the latter a smaller quantity becomes intolerable. Thus the second man chosen was a diabetic who had got first his allowance of carbohydrate sufficiently diminished so as to render the urine sugar-free. Then the grape sugar was given only half-an-ounce with food. He began passing sugar in the urine immediately after, and this continued in diminishing quantities for over 6 days, the total quantity thus passed out being more than double of that ingested. This additional quantity must thus have come from the system.

This passing out of excess of sugar ingested in the case of a diabetic must have its origin in the toxic breakdown of tissues caused by sugar in the blood in this disease.

There are many sure evidences of such tissue breakdown, such as, more urea appears in the urine, greater acidity, greater phosphates, and, on the whole, a larger amount of solids are marked in the urine.

This same case was again made to lessen his amount of carbohydrate in food sufficiently, and live in this condition for 6 months, in a sugar-free condition of his urine. At the end of that period the same amount of pure grape sugar was given him as in his first experiment, namely, half-an-ounce. He could then retain it all right. This showed that by keeping the urine sugar-free by early curtailment of carbohydrate in food, the lowered power is again restored by a natural process of cure in the system.

This significant fact gives us an idea of the proper method of treatment, namely, by trying to make the urine sugar-free first by only curtailing his allowance of carbohydrate, and if this does not do, by also administering drugs, the most successful of which is small doses of opium. After such treatment, commenced early, the power is very often seen to be considerably re-established later on.

Another interesting phenomena was observed in connection with this case—with reference to his body-weight. By the stoppage or diminution of carbohydrate he was actually found to gain in body-weight, whereas before that he was steadily losing. His power to assimilate carbohydrate having now been raised by keeping the urine sugar-free so long, the system demanded such a food which was not supplied, and so he lost weight. This being now allowed he began gaining in weight again. *This fact makes it imperative on us not to curtail carbohydrate too much*, but first we should carefully determine up to

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what quantity he can safely assimilate, and then give him that much—no more, no less.

The above-mentioned case, the type of a number of other similar cases upon whom I have experimented, was a relative of mine who lived with me for the time, so that I had opportunity of examining his urine and watch his diet and habits and symptoms most carefully. The urine was analysed immediately after it was passed, without allowing it to get decomposed by keeping. It has some difference with the single examination of the whole mixed-up quantity after 24 hours. In the latter case the urine decomposes, and the sugar and urea lessens to some extent, and the normal reaction considerably changes

I have mentioned six conditions above, in illustration of which, cases have been cited. Now I am going to refer to a few more and comment on them.

7. Reduction of "*opsonic index*" or the resisting power of the system against different kinds of micro-organisms is more or less both a common and general condition. But still it is unequal in different cases, commonest and most intense being in case of Streptococcus and Strephylococcus, less common and less intense in Tubercle and Pneumococcus. Vaccine injection is most rational in such cases—to lessen the chance of complications in diabetes.

8. *Opium* is the most widely used and most successful of all drugs used in the treatment of Diabetes. As has already been said, its action is mostly on the nervous system, specially that of the Splanchnic area, and causing vasomotor contraction in the liver which arrests the rapid transformation of glycogen into sugar. Its astringent action on bowels, and urine, and sweat, and saliva, in checking or diminishing their secretion, is best counteracted by Alkalis and Salines. A heavier dose should be given with Canabis Indica and Belladona to diminish dieuresis and promote sleep at bedtime; so that the patient may sleep undisturbed, which is such an important necessity in Diabetes.

It should first be seen how much diet regulation can achieve. If it fails even after reasonable curtailment of carbohydrate to render urine sugar-free, then only opium should be given to help its action. Again after some time, thus keeping the urine sugar-free with the help both of diet restriction and opium, then it is better to withdraw opium altogether or diminish it greatly. Generally in such cases the power is found to have returned more or less.

Two other things are of very great use in the treatment of Diabetes, specially that of adolescence and manhood, the 3rd, 4th and 5th decade of life, at which it is the commonest complaint in Bengal. These are meat-diet and regular muscular exercise.

Nothing is better in this respect than *raw meat* in some form.

Raw-meat pulp is in many respects better than raw-meat juice. The latter is more liable to get decomposed—not so the former. At the same time the latter contains more muscle serum as well as blood serum, both of which contain valuable internal secretion of the healthy animal from which it is taken. These are very valuable helps to assimilation. Here the proteid element which serves as the active agent in the improvement serves also to link the nourishment to the tissue cell which is the final destination. Hence the high value of proteid diet, specially of raw meat. Like a ferment a small quantity of it achieves a great result, a teaspoonful will lead to rapid increase in weight which its bulk alone cannot account for. I have found it of very great use, alone or with other measure, in most of the diseases which have to do with malassimilation, *e.g.*, Dyspepsia, Infantile merasmus, Diabetes mellitus, Phthisis Pulmonalis, etc. In diabetes it acting alone can appreciably reduce sugar considerably in the urine ; *vide* Raw-meat Juice Treatment in Diabetes (*Calcutta Medical Journal*).

Muscular Exercise.—Lastly comes muscular exercise. This greatly facilitates tissue-building by promoting the blood-flow generally and locally and fresh breaking down and building up of the tissue cells. Thus by causing tissue oxidation it causes tissue hunger which leads to tissue repair and tissue re-growth. The floating or free particles of sugar being thus utilised—in tissue building as well as for oxidation—the sugar is drawn away from the blood and from the urine as well. It probably acts in another way—namely by facilitating the flow of tissue antitoxin to the general circulation ; *vide* "Effect of regulated muscular exercise in sugar elimination in Diabetes" (*Tropical Disease Journal*).

I have spoken of some of the practical features of the nature of Diabetes and its rational treatment. Now I shall briefly touch upon a few more points in its Etiology and its Prognosis.

Etiology.—Men suffer eight times as frequently as females. The most susceptible age is the 4th and 5th decade of life. The sedentary and anxious brain workers mostly suffer. There are instances of husband and wife both having diabetes : the former got it first. This is commoner, namely, case of husband infecting the wife, than wife infecting the husband. Thus it may seem—that between married pairs there may be some contagion. A Mahomedan is known to me who has got 3 wives. He is himself a diabetic for many years—and two of his younger wives have been affected. They have got no family history of diabetes on their side. Manson thinks Diabetes to be a bacilliary disease.

Sons that are built like the father tend more strongly to inherit his disease. The daughters seldom do that. But their sons are sometimes similarly affected. In case of hereditary Diabetes—each next generation get it earlier, but die later, probably due to the development of better resisting power or tissue antitoxin in the system. In my experience it is seldom that diabetes has been seen in infants in India. A Marwari with Bengali habits gets it : and so does an European or Eurasian. Fat, short-built, robust people get it oftener than delicate people. Diabetics are generally voracious eaters, both before and during the onset of the disease.

Prognosis.—Young diabetics die early because it is their growing period of life. But most get it in the 4th and 5th decade of life. Brain-workers suffer most—more specially the educated middle class in Bengal. Sugar sometimes diminishes during the attack from some other acute diseases and disappears in severe complications. Disappearance without returning again has sometimes been seen in Pleurisy and mild attack of small-pox. Albumin is seen generally only in chronic cases produced from toxic arterioschlerosis brought about by sugar. Sometimes it totally disappears without any complication or relapse. Thus illustrates the well-known adage '*One disease toxin at times cures another.*' A diabetic patient may live long and healthy by proper care.

Free drink by better clearing away the sugar which is injurious from the blood of a diabetic prevents to some extent or save tissue damage which would otherwise result, although the total elimination of sugar in the urine is by free drink perceptibly increased in quantity, as also do urea and other soluble and insoluble components in the urine.

Here are some cases to the point : In the first case a man at 33, under a fixed diet, was passing sugar, the average of 7 days being nearly 400 grains per day. In the next week, under double the allowance of fluid, the average amount of sugar passed was 450 gr., nearly $\frac{1}{10}$ as much again. This has been found in many cases, in uria as well as in sugar.

II. STATISTICS.

All the statistics mentioned below are from a record of* 1,200 *cases.

a Albuminuria in Diabetes.

Within first year of onset ..	1% only.
Within five years ..	.. 3%
Within 10 years ..	.. 15%
In the Total ..	.. 10%, except at the very last stage.
Below 40 ..	.. 4%
Above 40 ..	.. 30%

Serum globulin only appeared in bad cases, and mostly at the last stage.

Remarks—

1. Albuminuria does not depend upon the quantity of sugar passed so much as upon the duration of the illness—later the oftener.
2. Depends also more upon the age of the patient—commoner in old age.

Evidently this is brought about by arterio-schlerotic condition in the kidney caused by toxic action of sugar in the blood, caused in the long run.

Generally sugar lessens when albumin appears. The cause of this is not very clear. It is to some extent probably retained within the system by the damaged kidney, and to some extent also by being changed into a different thing, which is perhaps more dangerous than sugar itself. But "acidosis" does not always go hand in hand with the diminution or disappearance of sugar.

b. Raw-meat Juice in Diabetes.

Only in some eighty cases it could be sufficiently tried. Some other patients began to take it earnestly then soon left.

Tried alone (without medicine) in early stage, it showed decided benefit in sixty per cent.,—sugar diminishing nearly thirty per cent. in the average.

Tried later, not of so much use, but often showed some diminution.

Elderly people most often showed intolerance, as indicated by smell in the stool and uric acid in the urine.

It does not increase albumin in diabetes where there is already albumin present, to the same extent as sugar does sugar in diabetes.

Even a small quantity given produces disproportionately greater improvement by fall of sugar, and increase in body-weight and tone.

It very often brings on uric acid in the urine on account of excess of cellular elements present; very often after some days' continued use it causes bad smell in the stool, when it should be stopped for some days.

Evidently the improvement marked is not so much due to the small quantity of proteid nourishment contained there, as due to the easily assimilable minerals in the form of organic compounds, and the internal secretion of the healthy animal's ductless glands.

Besides gelatin contained in it, and more specially in broths and meat extracts, saves tissue waste.

c. *Effect of regulated Muscular Exercise in sugar elimination in Diabetes.*

Better effect in middle-aged persons than in advanced age, or advanced stage of the disease, or in young diabetics either. Fatigue in exercise is very risky for its liability to cause " acidosis " and coma.

It diminishes sugar in the average by nearly thirty per cent. Shows that diabetes is caused as much by faulty glycolysis as by faulty glycogenesis. But sugar again tends to return some time after the exercise is stopped.

(*Vide* article in " Tropical Disease Journal," vol. 1907.)

d. *Incidence of the Disease.*

These are a few rough notes from my record ;—

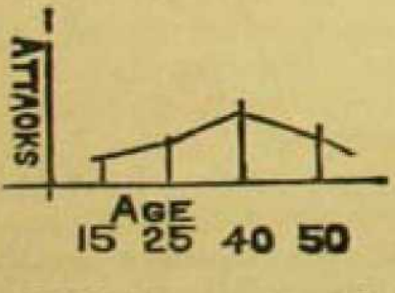
About fifteen per cent. in Lower Bengal among the educated class suffer—the largest number on record in the world's statistics.

Out of 100 cases recorded, according to occupation :—

Lawyers	25%
Doctors	22%
Clerks	13%
Merchants	12%
Teachers	11%
Zamindars	10%
Miscellaneous	17%

Among munsiffs or judicial officers one in five suffers—the class which is most extensively liable to the disease owing to their sedentary occupation, and arduous brain work, the two factors which so much predispose to this disease. Attorneys are relatively free.

According to *age* it is seldom seen in infants and children below sixteen.



Between 16—25	2% only
25—40	18%
40—50	12%
50 above	5%

This is as regards the first onset. Commonest in the fourth and fifth decade of life. I have seldom seen real diabetes below fifteen, but have seen occasional Glycosuria due to indigestion.

Periods of life (for Diabetes)—

Young age Diabetes	15—30
Middle age	30—50
Old age	50 and above.

For different purposes these age limits are differently put.

e. Physiognomy and Habits.

Out of a hundred cases according to build:—

Tall and robust	55%
Short, fat and flabby	45%
Thin built	5%

The first suffer one-fifth again as often as the second: they were generally voracious eaters in early years. The latter generally short-necked are more liable to albuminuria. Both albuminuria and diabetes are comparatively rare among the last, namely, the thin-built people.

Superficial area as compared with the cubical contents of the body, being proportionately less in fat people, it is believed to have some influence in developing a tendency to this disorder.

Factors contributing towards Diabetes:—

1. Over-eating, specially of carbohydrate and sugar.
2. Sedentary habits.
3. Brain work in excess, specially under worry and strain.
4. Shock, bodily or mental, predispose to the development of this disease.

f. Complications and Death.

Although diabetes is so common in Bengal yet many people affected with it drag on life for a long time. Again, though with under average health, yet they are known to do even arduous brain work all right. They are, as it were, to some extent, rendered tolerant by chronic suffering.

One attacked below thirty as a rule dies within a short time; seldom survives five years. In these, the quantity of sugar is generally excessive as compared with diabetes of an older age. The damage to health is also more quick and serious on account of the age being a growing period of life; most of these die of pulmonary phthisis or coma more frequently than carbuncle or gangrene which are troubles of low vitality and mortification and are oftener met with in older age.

Attacked between forty and fifty, patients struggle much longer. On the average the quantity of sugar these cases pass are much smaller owing to the nutritive function being less active in this age. Albuminuria is also more common as a complication. These cases develop carbuncle and gangrene oftener.

Attacked above fifty, the sugar is generally less. Albumin is commoner. But before that develops they continue long without much damage to health. These mostly die of gangrene, coma and nephritis bringing on uræmia. Acetone is less common and intense in these cases than in the cases below thirty or between thirty and forty.

These are a few more rough notes from my record in this connection :—

Deaths out of recorded cases of diabetes—

Young—below 30 P.P. 35%
Coma 40%
Carbuncle 10%
Intercurrent diseases 5%
Middle age—30 to 50 P.P. 30%
Coma 30%
Carbuncle and gangrene 35%
Intercurrent diseases 5%
Old age—above 50 Often complicated with chronic nephritis 60%
Uræmia 30%
Coma 20%
Gangrene and Carbuncle 30%
P.P. Pneumonia, etc., 10%
Intercurrent 10%

It seems from the above—

1. That this wasting disease acts most injuriously at the growing period of life.
2. That the quantity of sugar passed at this stage is the greatest than at any age.
3. Albuminuria is less common than it is as a complication of diabetes at older age.
4. These cases die quicker, seldom live longer than five years.
5. The most common causes of death are—
    1. Phthisis,
    2. Acetonuria is the most common and intense at this period (due to rapid pathological tissue breakdown).
6. Uræmia and carbuncle and gangrene are less common in this age than at subsequent periods, that is, in the old-age diabetics who show less disturbance and continue to struggle longer, mostly dying of Uræmia (Ab.) and mortification, Phthisis being

much rarer with them, except as a complication of an intercurrent acute pneumonia.

g. The Effect of Treatment.

Middle-aged people, *i.e.*, between forty and fifty, are most favorable cases for treatment. Early age diabetes as a rule proves quickly fatal and does not answer much to treatment.

In old age the course of the disease is slow and mild, but treatment does not much respond except as a paliative.

In the average, for the more favorable cases, if treatment be commenced early and properly adhered to, marked benefit follows.

1. Regulated muscular exercise specially with plenty of fresh air and out-door exercise—this alone can diminish in the average the sugar by nearly one-third (30%).
2. Raw-meat juice treatment (℥ii will do) will often serve to diminish sugar nearly as much. In both these the general sense of muscular tone and well-being becomes apparent.
3. Simply diet restriction in early cases has been found to apparently cure five per cent. of cases.
4. Opium in some form—the most generally used and efficacious drug in diabetes—can often diminish sugar to half or even less. In mild cases it causes total disappearance which sometimes lasts permanently even without any more doses of opium.
5. Salines, alkalis, astringents, arsenic and other measures are helpful along with opium to help their action, or in case of mild diabetes of middle or old age, may be continued alone for a long time.
6. Climate in diabetes seems to be only indirectly helpful, the most important factors being food and habits at the time.

N.B.—1. The proportions and percentages given above are only rough averages, to convey some idea about the frequency of occurrence.

2. The majority of the cases upon which the above statistics are based have been seen long enough to form an idea about them.

III. COMMENTS.

Detailed records of urine in a case of diabetic coma.—The following items are important and should be carefully noted from time to time—

1. Total Nitrogen,
2. Uria,
3. Ammonia.

Important and significant changes in the relative proportions of these take place in conditions of "acidosis" in which hyperacidity becomes marked, and—

1. Oxybutyric acid,
2. Diacetic acid,
3. Acetone,

develop.

For ordinary healthy oxidation in a normal state, carbohydrate supplies a portion of the oxygen necessary. When this is wanting in the food the fat splits up to supply it. In this unnatural process lower fatty acids develop, such as butyric acid, from which oxybutyric and diacetic acids and acetone are developed stage by stage. It is believed that the commonest seen is the last; the others are less and less frequent and indicate graver troubles; the significance of oxybutyric acid is very grave.

The series of resulting changes are believed to be the following: Under such diminished alkaline conditions of blood, Nature, in order to prevent the evil effect, tries to neutralise it by producing ammonia by the splitting of proteids with which the acidity is neutralised. Still a portion of the acid siezes upon the fixed alkali bases Na. and K. of the blood, with which Co_2 ordinarily loosely combines, for passing to the lungs for elimination through that channel. So two most important changes happen under this condition known as "acidosis" (*i.e.*, excessive acid formation in the blood caused mostly by fat-splitting taking place), which thereby diminishes the natural alkalinity of blood. To prevent which Nature manages by—

1. Producing ammonia by the splitting of proteid to neutralise it.
2. The excess of acid also combines with the fixed alkaline bases Na. and K., thereby preventing the free carriage and elimination of Co_2.

Thus ammonia is produced and Co_2 accumulates in excess in blood.

So the changes in the urine are—

1. The total Nitrogen in the urine increases.
2. Ammonia appears.
3. Uria diminishes.
4. Total acidity of the urine increases owing to increase in the acid in blood.
5. Oxybutyric acid, diacetic acid, acetone, appears one from the other by oxidation, in which acetone is the commonest, oxybutyric acid is the rarest, and of gravest significance.
6. Co_2 being thus retained in the blood, causes the pecu-

liar air hunger and sighing respiration so characteristic of diabetic coma.

Here I am mentioning a typical case in all its essential details for illustration—

This is about a young diabetic only thirty-three years of age, a pleader, with excellent build, and with both heredity and family history in the collaterals.

He developed the disease all on a sudden for which no apparent cause could be cited. The disease rapidly got worse and worse in spite of all dietetic restrictions and treatment. He died before the year was over.

Beginning with two hundred ounces of urine in twenty-four hours and gr. xxv of sugar per ounce, and rapid loss in weight, he began to show signs of acetonuria from the fifth month of the attack.

I am tabulating below the results of three examinations at the interval of nearly a fortnight each—at the very last stage of his disease. The albumin only appeared 12 days before his death.

Urine in—

1. November 23rd, 1904. He complained of nothing but was passing nearly 500 grains of sugar per day with a little acetone.
2. December 8th, 1904. The sugar diminished to 200 grains, and acetone was marked. Vomitted.
3. December 28th, 1904. Sugar diminished still further. Large quantity of albumin appeared in place of the trace that first appeared on the 16th, when he died of diabetic coma.

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